2 Standards-Based Curriculum and Assessment Design

The standards movement is no longer new. Virtually every state has generated standards for graduation and, in many cases, for student attainment at different stages of its K–12 curriculum. Many states have increased the legitimacy of their standards by accompanying them with various forms of assessment, many of them standardized tests and most aligned—to some degree—with the standards. Much attention has been focused on standards and tests, but unfortunately not enough attention has been directed at the development of exemplary standards-based curricula, excellent classroom materials, and appropriate forms of assessment. Most teachers are not provided the time to develop such materials, and most school districts are too busy simply enduring the transition from a credit-bearing to a standards-based attainment system to work on such matters, let alone to determine which parts of the current curriculum are essential and which are redundant or obsolete.

In an environment where the need to increase test scores exerts constant pressure, it is critical that schools and educators find mechanisms to orient school systems toward the value of teaching to the standards and toward the development of rigorous and thoughtful models of best practice. This is especially important when we consider the forces that make it difficult for teachers to decide what is best to teach, such as our irreversible and growing information explosion and the lack of a national curriculum that dictates what should be learned. At the same time, schools are influenced by textbook publishers who are removed from local schools.

Too often, educators are detached from the results of their teaching because they have had little to no voice in the key decisions leading to those results. They teach curricula they have not developed, use textbooks they did not necessarily select, use an externally imposed scope and sequence, and rely on assessments that are not usually sufficiently representative of the curriculum taught (DuFour & Eaker, 1998). In this context, it is imperative that schools provide teachers the time to develop and deepen the knowledge and skills they need to make informed and responsible decisions about what should be taught and about how such knowledge should be organized.

This chapter addresses the question: How do we operationalize a standards-based and learner-centered curriculum so that all teachers will understand what it entails? It shows how to approach "unpacking," selecting, and then incorporating state standards into exemplary curricula by using the skills of local experts, primarily teachers.

Through the careful analysis of three science curriculum units—primary, intermediate, and secondary—this chapter showcases the critical components of learner-centered, standards-rich curriculum and assessment (Martin-Kniep, 2000; Wiggins & McTighe, 1998). I decided to showcase three specific units rather than provide readers with a number of examples from different subjects and grade levels because I wanted to illustrate the design process in depth. I also wanted to show the elegance of same-subject, vertical (cross-grade level) articulation and the manner in which the same design elements appear in different grade levels. Other books do a better job of describing different design elements or the standards-based design process itself (see, e.g., Stiggins, 1994; Wiggins, 1998). The design components illustrated in the three units I will describe are

1. Essential and guiding questions that launch and sustain student inquiry throughout the learning experience; such questions are the cornerstone of several reform efforts, including the Coalition of Essential Schools
2. Standards and indicators from at least two content areas that legitimize the unit's purpose and space within the overall curriculum (Martin-Kniep, 2000; Marzano, Pickering, & McTighe, 1993); note that the learning standards referred to in each unit having to do with mastery in science or literacy are common in most states as well as in national standards
3. Integrated learning (Jacobs, 1997) and assessment opportunities that consider a range of developmental needs and interests and provide teachers with ongoing feedback about students' learning
4. Rigor and inquiry to support the need for students to see themselves as researchers as well as active learners immersed in the process of making meaning of new information (Newmann et al., 1995)
5. Authentic culminating assessments that provide a real audience and purpose for students' work (Newmann & Associates, 1996; Wiggins, 1998)
6. Reflective and evaluative opportunities that enhance strategic thinking and self-monitoring (Thorpe, 2000)

When teachers and administrators design and implement curricula with these components in mind, they can clearly articulate their selected content with appropriate instructional strategies and assessments, as will be seen in the following unit overviews.

Good curriculum is close to a work of art. It is unique and personal. These three units address significant science content as well as other features of standards-based design. Readers who are interested in this design process can use the same design elements to create units in all subjects and grades by using the design template in Appendix B.

Each of these units has now been taught in one or more public schools several times.

"Expertise" is a 16-week second-grade unit developed by Pat Lynch, an elementary school teacher in Manhasset Public Schools, a medium-sized suburban district in Long Island, New York.[1] Her unit focuses on the concept of scientific expertise, and more specifically on the question of whether students can showcase "expertise" without having it. The content is paleontology, and the culminating performance assessment is the opportunity to act as a teaching volunteer at the American Museum of Natural History for one day. Students develop the skills of observing, inferring, and drawing final conclusions while developing their own paleontological research. They also develop their literacy abilities of reading, writing, speaking, and listening. Their research fosters the developing of their interviewing, note-taking, technological, and organizational skills.

"Laws of Science" is a 7-week sixth-grade unit developed by Lisa J. Boerum, a middle school special education teacher in a very small school district, Sag Harbor Public Schools, Long Island, New York.[2] The unit is also centered on science. Students ponder the truth behind scientific laws as they immerse themselves in the study of an unknown substance and the use of that substance to design a spacecraft. Two essential questions constitute the organizing center of the unit: "Are all scientific laws true?" and "Are all truths laws?" Throughout the unit, students pose and test hypotheses, conduct scientific experiments with different types of matter, document their scientific explorations formally, and find creative ways of applying and demonstrating their increased understandings. The unit culminates in a science convention in which students consider school, community, regional, and national events related to laws, technology, and science.

"A Quiet Garden" is a 4-week, ninth-grade earth science unit developed by Elizabeth Bedell, a high school teacher in the William Floyd School District, a medium-sized school district in Long Island, New York.[3] In this unit, students ponder the question that is the unit's organizing center: "What is more constant than change?" Through a careful examination of weathering and the opportunity to design a garden pond for the school's courtyard, students are guided through an exploration of the earth and the universe as a dynamic system. In this unit, students engage in hypothesis testing and experimental design while solving a plausible and practical problem.

I will describe the first unit in great depth and use the intermediate and secondary unit descriptions to illustrate the common characteristics among the three units and the ways in which they support one another.

"Expertise," the second-grade unit, begins with a description of the culminating assessment: Students are invited to consider becoming a teaching volunteer in a museum. In this case, students had access to the American Museum of Natural History in New York, but other museums, exhibitions, or displays would do. The teacher poses the essential question "Can you create a good museum and not know?" and returns to the question at different points throughout the unit. Whereas the question appears to be rather awkward in its construction, second graders quickly understand that it forces them to decide how much knowledge is needed for someone to capture the most important aspects of any topic or to call oneself an expert in something.

Most of the units described below and in subsequent chapters took place over several weeks. On selected days, whole periods or blocks were devoted to the activity; on other days, only a portion of the elementary day or part of the period or block was required. The point here is that this was not the exclusive instruction every day, although on some days it was.

The first 2 weeks of the unit establish students' prior knowledge of key concepts. These include expertise, research, museums, teaching volunteers, and paleontology. Concepts are introduced or clarified as needed.

The next 4 weeks focus on teaching the research process, including library use, note-taking, and technological skills. The support of the library media specialist is enlisted for this phase of the project to help teach library skills and provide materials. Texts related to paleontology are avoided at this point, so the emphasis is on the development of new skills, not on learning new content until that is appropriate.

During Week 7, students learn interviewing skills, generate lists of questions to ask a visiting teaching volunteer, conduct the actual interview, and write follow-up thank-you letters.

In Week 8, the focus of the project shifts toward developing student knowledge. Time is provided for students to become immersed in paleontology without yet having to incorporate their new research and note-taking skills. Most students at this age love to learn about dinosaurs and related information. Students explore materials available in the classroom and school library. Several books are read aloud by the teacher both to introduce major concepts and to model the reading of nonfiction.

During Weeks 9 through 11, students conduct independent research and are expected to apply their note-taking, library, and technological skills. Students continue to build their knowledge base about dinosaurs and current theories and controversies in the field of paleontology.

Weeks 11 and 12 are spent having pairs of students design plans for the exhibits in the dinosaur halls of a natural history museum. Each pair decides upon an organizational framework and uses research data to support the design they create. Using a teacher-created rubric, the class then assesses one group's project and uses that experience to inform further museum design revisions. (Rubrics and overviews related to the science units appear later in this chapter.)

Having seen and used a teacher-designed rubric (as opposed to a commercial one) to assess students' understanding in Week 12, students are now asked, in Week 13, to help the teacher design a rubric that will inform the creation, rehearsal, and assessment of their teaching volunteer performance. The class is divided into teaching volunteer groups of three to five members. Next, students in these groups self-select their own areas of expertise from a list of 25 exhibits currently on display in the American Museum of Natural History. Students are responsible for writing and performing the oral presentations for each area of expertise they have selected. They use their accumulated research documentation and the rubric to assist them in this process.

During Weeks 14 and 15, teaching volunteer groups rehearse both their individual presentations and the fluency of the total group presentation. Members use the oral presentation rubrics to coach each other. Students study maps to learn the location of particular exhibits in the museum.

The final week involves the teaching volunteer performance in the Dinosaur Halls of the American Museum of Natural History. Prior permission was arranged with the museum for this 1-day project. Teaching volunteer groups receive an individual schedule to adhere to and are responsible for leading their tour group through Saurischian Hall, the Omithiscian Hall, and the Teddy Roosevelt Rotunda. Tour groups are made up of parents and interested museum visitors. Parents are given evaluation forms, based on the rubric criteria that students have used before, to complete following the performance. Thank-you letters are written to museum staff, and a dinosaur cookie and juice party completes the unit, at which time students self-evaluate their participation in the unit.

Over the course of 19 weeks, the unit addresses and formally assesses a broad range of New York State Mathematics, Science and Technology Standards at the elementary level, including Science Standards 4.1a and 4.3b and Informational Systems Standard 2.1c. It also addresses most of the performance indicators in three out of four Language Arts Standards.

Undoubtedly, "Expertise" provides students with rigorous and rich opportunities to experience the benefits of knowing something so well they can teach it. This, in and of itself, is significant. The unit addresses much more than the content of paleontology. In fact, through this 19-week experience, students acquire a wide variety of reading, writing, measuring, research, and study skills. When one considers that the students who experience this unit are 8 years old and that, by the unit's end, they truly are able to function as docents in a museum of natural history, it is impossible not to be awed by the unit's power.

"Laws of Science" is an interdisciplinary language arts, science, and technology middle school unit that integrates language arts and science standards by adapting the Gateway to Educational Materials Science (GEMS) unit entitled "Oobleck" for a highly heterogeneous group of sixth-grade students, including several special education students.

The unit is launched with students responding to the essential questions: "Are all scientific laws true?" and "Are all truths laws?" Students then read aloud *Bartholomew and the Oobleck* by Dr. Seuss. Next, they work in small groups on a lab investigation to determine the properties of an unknown substance made of cornstarch, water, and food coloring. They use all their senses except taste in order to determine its properties. After the students individually chart their observations, the groups work to develop a hypothesis about the substance. They perform miniexperiments to prove or disprove their hypothesis about the substance.

After the experiments are completed, students participate in a science convention to determine the truth about the substance and to state it as precisely as they can using scientific terms. The groups come together to listen to their peers' experimental results and to critically discuss them. The goal is to determine the "laws" of the substance. As the groups share the properties they discovered during the lab investigation, the class determines if each property is true and valid or if there are any situations during which the property would not be true. Students resolve disagreements by adding phrases, defining terms, or experimenting further to arrive at the truth.

In the next segment of this unit, students apply their knowledge and understanding about the properties of the unknown substance as they design a spacecraft that is able to successfully land on and take off manually from an ocean of the substance. Students work in their groups to design a plan considering the substance's properties. Using available materials and their own imaginations, they construct a model based on their design plans.

The final project involves having students work individually or in a group to develop a performance project that creatively addresses the answers to the essential questions. They use prior knowledge from previous science units and research various scientific laws. Finally, they address selected school, community, regional, or national current events related to laws, technology, and science.

In "Laws of Science," students question the meaning and value of truths and laws by experiencing and experimenting with them. The artistry of the unit lies in its careful attention to the inquiry process, as is evident by some of the questions that students address. These questions include:

- What process did we go through to arrive at the "laws" of the substance?
- What was easy or difficult in determining the "laws" of the substance?
- In what ways are we scientists?
- What have you learned from your peers through this convention?
- In what ways did your group work and communicate effectively?
- Explain the process you went through to design your spacecraft.

- Explain the difficulties you experienced *and* how you overcame them.
- Explain what other features could have gone into your design *and* why your chosen design is optimal for a successful landing and take-off.
- In what ways does technology help us to arrive at truths?

This unit succeeds in enabling students to acquire essential inquiry and communication skills. It also enables them to integrate literature, science, and technology in natural and meaningful ways. Among the state standards and performance indicators that are formally assessed are the following New York State Mathematics, Science and Technology Standards at the intermediate level: Standards 1a, b, c, d, e, f, h, and i; Standard 4b; and Standards 5a, b, c, d, and e. The unit also assesses numerous performance indicators in all four New York State English Language Arts standards.

In "The Quiet Garden," a ninth-grade earth science unit, students are asked to design a garden pond for a school courtyard. In the design procedure, they specifically assess the suitability of common rocks as decorative materials around the pond. The focus is to have students gain confidence in using the scientific method by creating hypotheses, predictions, and tests that they then analyze, allowing them to modify the hypotheses and ponder new questions that arise.

The unit begins with an essential question, one that runs through the entire earth science curriculum: "What is more constant than change?" Students are expected to view the earth and the universe as a dynamic system after studying earth processes.

Students then consider the question "What causes rocks at the earth's surface to change?" The discussion flows into the concept of weathering and the agents that bring it about. To put a practical and proximal twist to the concepts, students are directed to design a garden pond for a nearby courtyard, using the scientific method to determine which commonly available rock materials would be suitable as coping stones and decorations.

The unit includes opportunities for students to work as a whole class, in small groups, and individually. Many activities begin in the large-group or collaborative setting (brainstorming, class discussions, and developing hypotheses), move to a smaller lab group for further investigation (designing experimental procedures and carrying out experiments), and end as individuals use the new knowledge to produce lab reports, a garden plan, and journal responses. Often class discussion of an individual's work leads to a new cycle of investigation.

As with the preceding units, inquiry is central. The unit's craft lies in the application of scientific content to the solution of a problem. The unit formally assesses seven performance indicators in Standard 1, three performance indicators in Standard 4, and three performance indicators in Standard 7 of the New York State Mathematics, Science and Technology Standards. The unit also evaluates students on two of the four English Language Arts Standards.

All three of these units are centered on science and scientific inquiry, each with its unique angle or organizing center. Individually, they are all strong curriculum units that embody well-crafted design decisions. For example, each of them shows a strategic focus on specific standards. Tables 2.1, 2.2, and 2.3 show partial sketches of each unit (a portion of the schedule of activities and assessments and the standards addressed).

Though each teacher will have a unique style in showing the relationships among learning opportunities, assessments, and standards, all three unit sketches explicitly show the relationships among these three components. Furthermore, in all three cases, the three teachers who first did the projects cite standards and performance indicators that are

Table 2.1 Partial Sketch of the Unit "Expertise"

Week	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
4	**Teach Research and Note-Taking Skills**				
Activities	Library Media Center Introduce computer programs available for research: • Golden Books • World Book Mini-lessons: • Captions • Pronunciation	Library Media Center Introduce computer programs • Grollier's *Prehistoric Encyclopedia* Mini-lesson: • Captions	Library Media Center Introduce the Internet • Netscape • Bookmarks	Library Media Center Teach note taking • Paraphrasing • Selecting important facts	Library Media Center Teach note taking • Shortcuts • Use of phrases • Abbreviations
Assessments (pages cited are those of prototype)	Journal entry, p. 14			Journal entry, p. 14	Journal entry, p. 15
Standards	ELa1–1a, 1b, 1d MST2–Info. Sys. 1C	ELa1–1b, 1d MST2–Info. Sys. 1C	ELa1–1b, 1d MST2–Info. Sys. 1C	ELa1–1b, 1c	ELa1–1c
5	**Teach Research and Note-Taking Skills**				
Activities	Mini-lessons: • Topic • Main ideas	Mini-lessons: • Highlighting	Mini-lessons: • Charts, maps, and captions • Skimming for specific information • Relevant information • Irrelevant information	Mini-lessons: • Classification • Highlighting	
Assessments	Journal entry, p. 15	Cloze exercise—How to Do Research, pp. 47–48	Journal entry, p. 15	Journal entry, p. 15	
Standards	ELa1–1a, 1c	ELa1–1c	ELa1–1a, 1b	ELa1–1c	
6	**Teach Research and Note-Taking Skills**				
Activities	Mini-lesson: • Finding related topics and headings	Mini-lesson: • Organizing research	Mini-lesson: • Setting up research file box		
Assessments					
Standards	ELa1–1b	ELa–1c	ELa1–1c		

Table 2.2 Partial Sketch of the Unit "Laws of Science"

Week 5: Monday	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
Module 6	**Module 6**	**Module 7**	**Module 7**	**Module 7**
Scientific Convention	*Scientific Convention*	*Spacecraft Design: Plan and Design*	*Spacecraft Design: Construct and Test*	*Spacecraft Design: Test and Reflect*
The students will participate in a scientific convention to determine the truth about Oobleck and to state it as clearly and completely as possible.	The students will participate in a scientific convention to determine the truth about Oobleck and to state it as clearly and completely as possible.	The students will apply their knowledge and understanding about the properties of Oobleck in order to design a spacecraft that would be able to successfully land on and take off from an ocean of Oobleck.	The students will apply their knowledge and understanding about the properties of Oobleck in order to design a spacecraft that would be able to successfully land on and take off from an ocean of Oobleck.	The students will apply their knowledge and understanding about the properties of Oobleck in order to design a spacecraft that would be able to successfully land on and take off from an ocean of Oobleck.
Summative Assessment	*Summative Assessment*	*Formative Assessment*	*Formative Assessment*	*Summative Assessment*
Participation in scientific convention, pp. 62–68	Participation in scientific convention, pp. 62–68 Rubric for scientific convention, p. 61 Responses to reflection questions, p. 69	Plans for spacecraft design, p. 76 Rubric for spacecraft design, p. 77	Plans for spacecraft design, p. 76 Rubric for spacecraft design, p. 77	Responses to reflection questions, pp. 78, 80–81 Spacecraft model reflection prompt Rubric for spacecraft design, p. 77
Indicators: (See Overview) MST 1h ELA 1b ELA 3a ELA 4a, b	**Indicators:** (See Overview) MST 1h ELA 1b ELA 3a ELA 4a, b	**Indicators:** (See Overview) MST 5a, b, c, d, e	**Indicators:** (See Overview) MST 5a, b, c, d, e	**Indicators:** (See Overview) MST 5a, b, c, d, e

Note: Page numbers referred to in the assessments are those of the published prototype.

addressed by the unit's assessments and not the ones that are present in the lessons themselves. The reason for this bias is that true evidence of standards attainment is found in what students, not the teacher, can do.

Given the significant and explicit attention to standards, these units, in fact, prepare students to meet the demands of state tests without reducing the integrity of the science curriculum. This is illustrated by the three boxes of sample items starting on page 24, typical of the intermediate-level science assessment administered in New York State at the eighth-grade level.

All three units use essential and guiding questions as learning and assessment opportunities. Teachers use these questions as diagnostic and summative assessment by asking students to ponder them at the beginning and end of each unit and, in some cases, to

Table 2.3 Partial Sketch of the Unit "A Quiet Garden"

	Module Plan
Module 4	A Practical Application of the Scientific Method: Studying the Factors That Affect the Type and Rate of Weathering
Learning opportunities	The Scientific Method ➢ Review the scientific method and develop rubric for a good experiment; use an example to go through the steps of the scientific method. ➢ As a group, students observe weathered rocks and develop the hypothesis: *"Rocks weather when they are exposed to the atmosphere, hydrosphere, and biosphere."* ➢ As a class or in lab groups, make predictions, and have students design experiments to investigate the factors that affect the type and rate of weathering (surface area, mineral composition, temperature, duration of weathering, etc.). An example: "*If rocks weather by exposure to the hydrosphere, then the exterior of rocks will be more weathered that the interiors."* ➢ Carry out experiments, gather data, devise report sheets, create graphic presentations, write lab reports. Reflection ➢ Use rubric to evaluate their experiments. ➢ Seek connections between their experiments and the garden design. ➢ Class discussion: "What have we learned?" Share results and problems and formulate new questions.
Assessments	Experiment designs (predictions, materials lists, procedures) Report sheet and graph layouts Observations recorded on report sheets with graphs of data Written report Reflection
New York State standards/outcomes	MST 1, 4 ELA 1, 3, CDOS 3a, Reflection
Elements of the Earth Science Program modification curriculum addressed	Unit 4: A1, 2, 4, 5 (in addition, there is an opportunity at this time to review Unit 2: Rocks and Minerals)

self-assess the changes between the two using explicitly stated criteria in the form of a checklist or rubric.

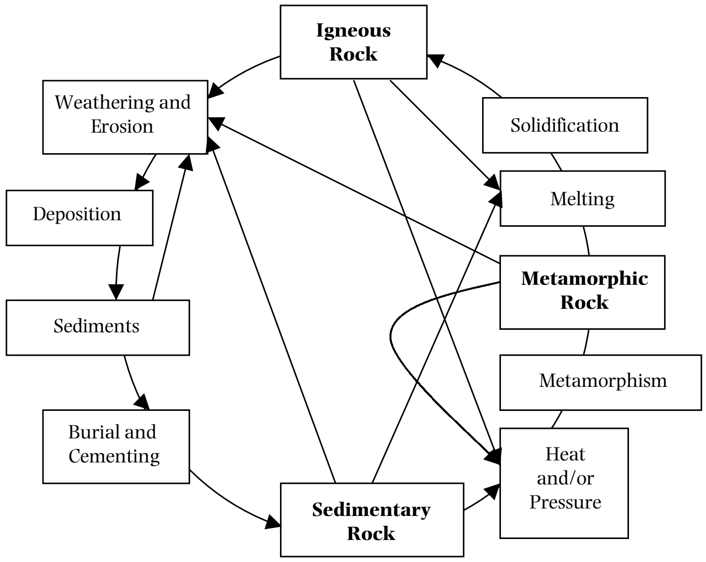
Boxes 2.4 and 2.5 are pre- and post-test answers to the essential question from a ninth-grade student in Elizabeth Bedell's class who was also a third-time repeater of ninth grade.

The changes between the pretest and the posttest are significant. The pretest is composed of two generalizations with no support. The posttest response incorporates different aspects of the unit's contents. Furthermore, the student uses specific factual evidence to support the assertion that change is the only constant thing.

Teachers use the guiding questions to grapple with the unit's components. The questions also guide students' research and work toward a culminating authentic task.

The three units also consider the diverse ability and developmental needs of students by relying on learning experiences that cater to different learning styles and intelligences and by enabling students to make choices of either content or ways of representing it. In "Expertise," the choice revolves around a specific aspect of paleontology. In "Laws of Science," students can choose both the events they will address and the means for showing

Box 2.1 Item 1: Rock Cycle



Box 2.2 Item 2

A student plays tennis several times a week. She notices that the tennis ball seems to bounce higher on some courts than on other courts. She wonders if this has something to do with the surface of the court. Design an experiment to see if her hypothesis is correct. Include these elements in your response:

- State the hypothesis
- Identify the factor to be varied
- Identify two factors that should be held constant
- Clearly describe the procedures

Box 2.3 Item 3

For each question, write your answer in the space provided on the separate answer sheet.

Base your answers to Questions 35 and 36 on the charts below, which show two elements (iron and sulfur) and their properties. The arrows indicate that these elements may combine to form either a mixture of iron and sulfur or the compound iron sulfide.

Question 35. How could a student use a magnet to indicate that combining iron and sulfur to produce the mixture of iron and sulfur is a physical change?

Question 36. What evidence indicates that a chemical change took place when the iron and sulfur combined to form iron sulfide?

Box 2.4

What is more constant than change?

"Nothing Change happens everyday all day to everybody from light to dark, the time of day or everyday life as to your daily routine. Change is happening all the time which makes it the most common thing." *(Pretest, February 2)*

Box 2.5

"The only thing constant is change.

I know change is constant because of weathering that takes place and erosion. An example of the weathering and erosion is how much the beach has changed. Because of the weathering such as the wind, and storms. The beach has changed totally it was eroded and there is no more beach there. Streams also change all the time a stream can go from a young stream to a mature stream and then to an old stream. You know this be seeing how the stream gets steeper and wider. Glaciers are also another part of change. Glaciers are formed by more snow falling then melting. The glaciers can get bigger or smaller depending on the weatherthey are constantly changing. Rocks can also change constantly from weathering. The size and shape of a rock can change because of the weathering that occurs to it. The wind abrasion changes the shapes of rocks and erodes them. They change into new shapes." *(Post-test, March 23)*

how these events relate to truth, laws, technology, and science. In "A Quiet Garden," choice lies in students' having to devise experiments and strategies for designing an attractive, non-toxic, and durable pond with a solar pump, a plastic pond liner, and a budget of $150.

In all of these units, students are able to articulate their thinking and learning process and to evaluate their own and each other's learning. They are also able to use different learning modalities and, in some cases, their preferred intelligence to demonstrate the learning attained as a result of the unit. All of these unit attributes are indicative of effective teaching practices, which, in turn, correlate positively with student achievement (Stronge, 2002). In "Expertise," students keep a journal of their learning. Box 2.6 is a sample unedited entry.

In "Laws of Science," students record their thoughts as they formulate hypotheses such as the ones shown in Boxes 2.4 and 2.5.

Model Format: IF (my action) **THEN** (substance's reaction).

Student Samples:

1. **If** I hold it in my hand, **then** it will melt because of body heat.
2. **If** I poke it, **then** it will feel thick.
3. **If** I touch it, **then** it will stick to me.

Box 2.6

"Yesterday we went to the high school and in the board room and we each had to do speeches for their slides. The people who did it where: James, Jamie, Allison C., John, Peter, Megan La., and I. The six people and I had about 4, 5, or 5 speeches. We did it in front of an adeance and the board of Ed! Our parents wher part of the adeance. We wher osaum! We are practacly too famous for second graders!!"

4. **If** I tilt the bowl, **then** the substance will make a wave.
5. **If** I squeeze it, **then** the liquid substance will come out.
6. **If** I put the substance on paper, **then** it will dry.
7. **If** I add water to the substance, **then** it will drip.
8. **If** I pick up the substance, **then** it will crumble.
9. **If** I keep the substance on my hand, **then** it will dry.

Students also respond to reflective questions such as the following ones:

- How well do your procedures and observations relate to your hypothesis?
- Was your hypothesis proven to be true? Why or why not?
- From your experiment only, do you have evidence to support that the substance is a SOLID? a LIQUID? a GAS? Pick one and explain why.

In "A Quiet Garden," students respond to reflective questions throughout their inquiry. Such inquiry questions include:

- What have you learned from your experiments that you can apply to the pond design?
- What questions do you have about the materials? (Remember, there will be a fountain with running water in the garden.)
- How realistic were your experiments? (Did they simulate the actual conditions?) Is it important that the experiments simulate the garden conditions?

All three units include explicit performance criteria embodied in checklists and rubrics that students use to assess and monitor the quality of their work. These criteria are directly related to the state and national standards that support the units and in fact often "lift" that language directly from these standards. Tables 2.4, 2.5, and 2.6 include sample rubrics.

As a set, these units illustrate the beauty of a spiral curriculum that is respectful of students' changing needs and understandings. One can easily imagine that the knowledge and skills acquired in "Expertise" would enable students to maximize their learning from "Laws of Science" and that the latter would greatly enhance students' work in "A Quiet Garden."

Table 2.4 Partial Rubric From "Expertise"

Rubric for Teaching Volunteer Performance

Criteria: Oral Presentation Skills

	Superior	*Good*	*Satisfactory*	*Needs Improvement*
Volume and intensity	Constantly anticipates and adjusts for external conditions and the size of the space and audience. Volume, intensity, and speaking locution are adjusted accordingly so that museum visitors can hear well.	Volume and intensity are appropriate for the area and conditions. Adjusts to changes as they become apparent. Museum visitors hear well most of the time.	Volume and intensity tend to stay constant at a satisfactory level. Doesn't monitor and adjust sufficiently to changing conditions. Some museum visitors may not hear as conditions alter.	Volume and intensity too loud or soft for the area and conditions. No monitoring and adjusting to conditions. Distracting volume and intensity for museum visitors. Interferes with delivery of information.
Articulation	Highly articulate. Speaks clearly and distinctly. Careful enunciation. Lively expression. Speaking is easily perceptible to museum visitors, and its expressive quality enhances the power of the speaking.	Vocal expression is clear and distinct. Museum visitors can hear and understand the Teaching Volunteer's spoken words.	Vocal expression clear at times and indistinct at other times. Museum visitors occasionally have difficulty hearing and understanding the Teaching Volunteer's spoken words.	Speaking is indistinct. May mumble and/or slur words. Careless enunciation. Museum visitor unable to understand the speaking.
Pace of delivery	Consistently appropriate for museum visitors to take in the material. Neither too fast nor too slow. Adjusts pace to meet visitors' needs. Presentation is completed on time, and the pace is steady throughout.	Steady pace that is neither too fast nor too slow. Some adjustments are needed to accomplish an on-time completion. Adjustments don't interfere with museum visitors' experience.	Pace inconsistent. At times too fast and/or too slow. Museum visitors feel rushed at times or feel that the presentation drags at others. Tour finishes close to the allotted time.	Pace is too fast and/or too slow. Tour finishes too early or too late.
Physical presentation	Maintains an engaging yet calm, poised, professional demeanor at all times and under all circumstances. Appropriate eye contact is maintained throughout. All gestures and motions are appropriate and enhance the speaking and the audience's comfort level and participation. Body positioning doesn't block visitors' view of exhibits.	Appears comfortable in role. Posture, motions, and body language appropriate. Does not stand so as to block view of exhibits.	Posture, motions, and body language are distracting at times. Sometimes appears anxious and/or uninterested and appears comfortable at other times. Eye contact mostly appropriate; at times may avoid eye contact and/or stare inappropriately. Body position at times blocks museum visitors' view of exhibits.	Body language suggests anxiety and/or lack of interest. Appears uncomfortable with the role. Motions, gestures, and body language are distracting for museum visitors. Stands so as to interfere with view of exhibits.

Table 2.5 Partial Rubric From "Laws of Science"

Science/Language Arts:

Date:

Dimensions	*Novice*	*Apprentice*	*Practitioner*	*Expert*
Observations/ results – Organization – Relevance – Supporting details	Observations are presented but are difficult to understand. Observations/ results need to relate to hypothesis with evidence of observable facts. Observations/ results need to have details that clarify the observations and support the procedures, materials, and hypothesis.	Observations are evident but need to be presented in a chart or diagram for clarity and organization. Observations/ results are indirectly related to the hypothesis with facts that need to be stated clearly. Observations/ results have details, but the details need to be explained further to more fully support the procedures, materials, and hypothesis.	Observations are clear and organized. Observations/ results relate to hypothesis. Observations/ results contain details that support the procedures, materials, and hypothesis.	Observations are presented in a clear, organized, identifiable manner, using charts, diagrams, or paragraphs. Observations give evidence of observable facts that strongly relate to the hypothesis. Observations/ results contain a variety of details that support the appropriateness of the procedures, materials, and hypothesis.
Conclusion – Understanding – Use of data – Supporting details	An ending thought has been written, but it needs to communicate what has been learned about how procedures and observations prove or disprove the hypothesis. Conclusions are drawn, but the relationship to the data is not clear. Explanations need to be written and supported with relevant details.	Communicates what has been learned, but thoughts need to relate to how the procedures and observations prove or disprove the hypothesis. Conclusions are supported by data but need to be explained. Details are limited and need to be relevant to the procedure and hypothesis.	Communicates what has been learned about how procedures and observations prove or disprove the hypothesis. Conclusions are supported, but the scope of the conclusions is broader than what the data support. Relevant details help support part of the conclusions.	Communicates what has been learned about how procedures and observations prove or disprove the hypothesis with a significant level of insight. Conclusions are supported by data with explanations, and all data are accounted for. Explanations are supported with a variety of relevant detail.

Table 2.6 Partial Rubric From "A Quiet Garden"

Teacher-Designed Rubric for Scientific Experiments

	Researcher	*Research Assistant*	*Laboratory Assistant*	*Lab Assistant-in-Training*
Data collection and analysis (the degree to which the observations are made and analyzed with care)	Observations are thorough and relevant; measurements are accurate, with all appropriate units included Data are complete and organized, with all units identified Correctly applies mathematical concepts, correctly displays calculations (formula, substitution, and answer) with an explanation of how and why the calculation was done Graphs and charts are labeled and titled; visual representations are referred to in text; dependent and independent variables are appropriately situated on graph; key is clearly labeled	Observations are relevant; measurements are accurate, with most appropriate units included Data are complete and organized, with most units identified Correctly applies mathematical concepts, correctly displays calculations (formula, substitution, and answer) Graphs and charts are labeled and titled; dependent and independent variables are appropriately situated on graph; units and/or key is missing	Observations and measurements contain consistent errors Data are complete, but organization makes it difficult to follow; units are missing, incomplete, or incorrect Correctly applies mathematical concepts; calculation is complete but work is not shown; units may be missing Graphs and charts are incomplete; dependent and independent variables are reversed on graph; units, labels, and/or titles are missing	Observations and measurements are incomplete or contain large errors Data are complete, but organization makes it difficult to follow; units are missing, incomplete, or incorrect Omits calculations or incorrectly applies mathematical concepts Lacks visual representations (graphs or charts)

WHAT DOES IT TAKE TO DEVELOP A STANDARDS-BASED, LEARNER-CENTERED UNIT?

The three units described in this chapter were written by teachers who made a significant commitment to learn about standards-based design, to incorporate it into their classroom practice, and to document it in a way that would allow other teachers to understand and follow all their curriculum and assessment decisions. Such commitment, in the form of 5 release days during the school year and 1 week in the summer in 3 consecutive years, was supported by their principals and district superintendents. In that period of time, teachers designed the preceding units but also drafted and refined several more. They also became local curriculum and assessment resource providers for other teachers in their schools and facilitated the design and implementation of units for grades K–12.

There are other ways of involving teachers in standards-based curricula. Among these are engaging them in a gap analysis of the operational curriculum (asking them to map their lessons and units against local and state standards and then make adjustments and revisions to their curriculum to better address underemphasized standards) or in a gap analysis of the learned curriculum (asking them to assess the distance between what they believe are standards-based lessons and assignments and resulting student work from students representing a range of academic attainment). My experience is that while these processes are extremely worthwhile, designing a complete standards-based unit provides teachers with a deeper understanding of the standards vis-à-vis the curriculum than any other curriculum-related process. Furthermore, designing a unit for an audience other than oneself results in a deeper understanding of the relationship among the different components of standards-based and learner-centered design. This, in turn, results in the development of teachers' capacity to help other teachers design.

The teachers who developed these units needed a forum that embraced curriculum development and that supported collaborative work. Each draft of the template was reviewed and analyzed by other teachers involved in curriculum design, as well as by local and outside content and curriculum experts. This extended community validated teachers' efforts and provided the motivation to produce high-quality work.

HOW DO WE HELP TEACHERS DEVELOP HIGH-QUALITY STANDARDS-BASED UNITS?

Teachers need significant background in standards-based design and learner-centered education. This background is acquired over time, and it is critical that staff developers and administrators give teachers many opportunities to review the standards and create units that support them. The translation of local, state, or national standards into teachers' own words; the identification of content, skills, activities, strategies, and assessments that teachers use to address specific standards and indicators; and the rating of the extent to which teachers' curricula introduce, reinforce, or seek mastery of specific performance indicators are all strategies for helping teachers unpack and internalize the standards.

To support the design process, teachers can benefit from design templates and frameworks. The teachers who wrote these units used the design template included in Appendix B. This template uses a backwards or outcome-based process such as the one found in Marzano et al. (1993) or Wiggins and McTighe (1998).

In this template, teachers begin the process by identifying an organizing center around which the unit will be designed. Ideally, this organizing center is generative, enabling teachers to address a concept, issue, or problem in depth while making meaningful interdisciplinary connections as well as connections between the learner and the material taught. Next, teachers consider the outcomes and standards they want students to attain at the end of the unit. They then operationalize these outcomes and standards by addressing the questions:

- What does each outcome/standard look like?
- What does each mean in my classroom/subject/grade?
- What will students produce if they are working to attain the outcomes/standards?

Teachers then identify the assessments they need to collect or administer before (diagnostic), during (formative), and after (summative) the unit is completed to demonstrate that students have grown toward and/or achieved desired standards or outcomes. As part of the assessment considerations, teachers ponder the questions:

- How will I communicate what mastery or accomplishment means?
- What does quality mean for me and my students?
- How good is good enough?

Once teachers have addressed issues related to assessment and performance criteria, they shift their attention to the unit as experienced by the learners. They ponder the possible use of essential and guiding questions to harness students' interest and motivation and to focus their teaching. They also identify or design the learning opportunities they need to provide so that different kinds of students can attain desired learning outcomes and standards.

It is not easy to design a unit like the ones previously described, but this is what is required if the state and national standards are going to be attained and if we want to increase a school's capacity to design, assess, or adapt quality curricula to enhance student learning. Ideally, schools must find time for teachers to come together for periods of 7 to 20 days over a year or two, depending on the complexity of the unit, to determine the standards that are addressed and are missing by their current curriculum materials, to design performance and authentic assessment measures that incorporate desired standards, to collect materials, and to create rubrics and other tasks. A unit draft undergoes significant change during the implementation phase and often gets transformed every time it is taught. Teachers need shorter meetings after a unit is taught to review what happened and make revisions to increase its effectiveness. Staff developers can play a critical role in supporting this process by reviewing and responding to teachers' work on a continuous basis.

We all live in the real world of schools and understand that every teacher cannot be granted one or more weeks of design time each year; however, schools must provide some time for small groups of teachers to have time each year for this effort, or the standards will have no meaning in students' lives. Once units are created, other teachers at a grade level can use them as they are or with very minor modifications. Staff developers and administrators can provide the structures for such use and adaptations.

Providing teachers with a collaborative forum for the development of curricula where teachers help each other design, review, and revise their work is likely to raise the bar for each teacher's unit design, as well as to facilitate the creation of collegial structures within the school.

Despite the demands of time and energy, the investment in standards-based design is worth it. Data from a variety of studies provide evidence that teaching experience is the single most important factor in enhancing student learning (Wright et al., 1997) and that it results in an up to 30% increase in students' academic performance (Stronge, 2002).

When teachers experience and practice this standards-based design process, they accomplish far more than the design of a unit. The process of articulating all the design components into a whole unified by an organizing center forces teachers to ask themselves critical questions about all the content they teach and not just about the content of the unit they are designing.

Furthermore, when teachers implement the unit they have designed, experience the benefits of ongoing assessment, feel the power of authentic culminating experiences, and recognize the value of ascertaining students' thinking processes as they unfold, they internalize the value of these learner-centered practices and embed them in their day-to-day practice. As increasingly effective teachers, they serve as powerful examples of lifelong learners for their colleagues and for their own students.

POSSIBLE QUESTIONS FOR THE READER

1. Who develops the curriculum in your school or district? When is that curriculum developed? How is it developed?
2. What standards of quality, if any, guide the curriculum development process in your school or district? Who enacts those standards?
3. What role do administrators and staff developers play in the curriculum design or revision process?
4. What are the expectations related to who uses the curriculum that is developed and how the curriculum is used?
5. How are teachers supported in the internalization and use of national or state standards?
6. How are the design and implementation of curriculum and assessment processes that meet quality standards supported in your school or school district?
7. What processes exist to ensure that students learn national or state standards?

RECOMMENDED BOOKS ON STANDARDS-BASED CURRICULUM AND ASSESSMENT DESIGN

Burke, K. (Ed.). (1996). *Authentic assessment: A collection.* Palatine, IL: IRI/Skylight.

This collection succinctly dispels the myth that *authentic assessment* is merely the latest buzzword. It traces the history of National Assessment of Educational Progress (NAEP) trends, competency testing, and influences of the National Governors Association upon authentic instruction. It then defines, explains, and provides examples of authentic, alternative assessments. Many secondary school examples are included. In addition, each section includes an extensive bibliography of related articles.

Drake, S. (1998). *Creating integrated curriculum.* Thousand Oaks, CA: Sage.

This book offers elementary, middle, and high school educators an extensive look at different approaches to curriculum integration. It provides a rationale for integrating the curriculum and includes models to assist in understanding various approaches. Sample lessons, units, and planning strategies help the reader understand and employ the basic concepts of interdisciplinary, thematic, and problem-based approaches to learning. Drake dispels the notion that effective curriculum integration is "business as usual." It is rather a critical part of educational reform involving curriculum, standards, assessments, and instructional strategies.

Ellis, A. K., & Stuen, C. J. (1998). *The interdisciplinary curriculum.* Raleigh, NC: Eye on Education.

This book includes chapters on the nature of knowledge, the components of the inquiry process, concept formation, and reflective thinking. It also addresses issues such as

integration of subject matter and academic integrity, the importance of major themes, and the role of experience in learning. The authors offer classroom-tested examples and models of interdisciplinary curricula at different grade levels and involving different subjects.

Hart, D. (1994). *Authentic assessment: A handbook for educators.* New York: Addison-Wesley.

This book is an excellent assessment primer. It provides readers with a basic understanding and knowledge of assessment and related issues. Each chapter contains definitions of pertinent terms and provides many examples in chart or graph form. The book also includes an extensive assessment glossary and a bibliography of supporting resources in assessment. The topics covered by this book include standardized testing as compared to authentic assessment; portfolio assessment; performance assessment; and scoring and grading strategies.

Hill, C., & Norwick, L. (1998). *Classroom based assessment.* Norwood, MA: Christopher-Gordon.

This book is the first of four in a new series on assessment. It presents practical ways to collect information about young learners. It addresses teacher notebooks, an observing-as-assessment continuum, assessment forms, and recommended readings. It emphasizes assessments in reading and writing, but other content areas are also addressed.

Jacobs, H. H. (1997). *Mapping the big picture: Integrating curriculum and assessment K–12.* Alexandria, VA: Association for Supervision and Curriculum Development.

In this book, Jacobs writes about curriculum mapping, particularly as a procedure for collecting data about a school district's curricula by using the school calendar as an organizer. The school calendar serves as the framework for this procedure. Jacobs goes on to explain that curriculum mapping increases the possibilities for short- and long-term planning and clear communication among educators. Curriculum maps allow teachers to find repetitions, gaps, meaningful assessments, potential areas of integration, and areas needing work. Jacobs also devotes a chapter to the definition and importance of essential questions.

Kuhn, T. (1992). *Mathematics assessment: Alternative approaches.* Columbia, SC: National Council of Teachers of Mathematics.

This video and viewer guide focus on alternative assessment in mathematics. The video is broken up into six segments, which cover the introduction and implementation of alternative assessment in the mathematics classroom. Each video segment has two parts, classroom and faculty interactions and panel discussions. The guide provides video summaries and extended activities for staff development. This is a good tool that staff developers can use to introduce alternative assessment in mathematics.

McCollum, S. L. (1994). *Performance assessment in the social studies classroom: A how-to book for teachers.* Joplin, MO: Chalk Dust.

This book explores authentic social studies performance assessments in Grades 4 through 12. Each of the 14 individual tasks is directly tied to social studies concepts, content, and skills and is related to real-world experiences. The author (a social studies teacher) gives the reader clearly outlined task instructions, materials, Blackline Masters, task-specific rubrics, student checklists, and examples of students' work.

Miller, B., & Singleton, L. (1995). *Preparing citizens: Linking authentic assessment and instruction in civic/law-related education.* Boulder, CO: Social Science Education Consortium.

This book makes critical connections between civic education curriculum, instruction, and assessment. Among its strengths are (a) a collection of authentic tasks supported by assessment procedures; (b) a strong emphasis on the use of rubrics in classroom instruction, including clear step-by-step instructions for development and revision; and (c) samples, methods, and suggestions in classroom instruction that are grounded by presentation through personal experiences and case studies of teachers who have used them. The teacher reflections and revisions are also especially helpful in providing insight into the design of tasks.

Newmann, F. W., Secada, W. G., & Wehlage, G. G. (1995). *A guide to authentic instruction and assessment: Vision, standards and scoring.* Madison: Wisconsin Center for Education Research.

This book identifies three criteria for authentic learning tasks: the construction of knowledge, disciplined inquiry, and value beyond school. The authors discuss these criteria as they relate to tasks, instruction, and student performance and further break the three criteria down into standards. Examples from mathematics and social studies are provided for each of the standards identified. These examples cross grade levels. Finally, the text provides scoring criteria for judging the authenticity of assessment tasks, instruction, and student performance.

Stiggins, R. J. (1994). *Student-centered classroom assessment.* New York: Merrill.

This book focuses on ways to develop and use sound classroom assessments and on strategies to involve students as partners in the assessment process. It presents a balanced look at all kinds of assessments. It includes a variety of classroom applications; discusses ways to communicate student achievement, including report cards versus portfolios; and provides a reflection section that could be used in staff development activities.

Wiggins, G. (1998). *Educative assessment: Designing assessments to inform and improve student performance.* San Francisco: Jossey-Bass.

This book is aimed at enabling educators to create assessments that will improve performance and not merely audit it. It calls for the use of authentic tasks, feedback methods for teacher and students while learning is in progress, and resulting adjustments during the entire process. It is replete with charts, graphs, examples, and diagrams that make it both readable and practical. The models provided can actually be altered and used in the classroom without much work. Standards and criteria are explained and samples of rubrics included. The rubric construction is thoroughly demonstrated. The intricacies of portfolio assessment are also explored, and sample charts for inclusion and evaluation are provided.

Wiggins, G., & McTighe, J. (1998). *Understanding by design.* Alexandria, VA: Association for Supervision and Curriculum Development.

Teachers would agree that, whatever the content, their goal is that students will understand a concept or process. But what is understanding? The authors explain six facets of understanding. They propose a "backward design" model: after determining what students need to know and be able to do, teachers should design the assessments that show evidence of this understanding. Readers are carefully taken through this design process, with classroom examples as well as design templates. Issues of constructivism, conceptual change, and strategies for deciding the content that does not need to be taught naturally arise in the discussion. Though primarily useful to the classroom teacher, this book should be of considerable interest to any professional involved in curriculum design.

NOTES

1. Pat Lynch, "Expertise," 1999, a Standards-Based Curriculum and Assessment Prototype available from the Center for the Study of Expertise in Teaching and Learning (CSETL) Web site, *www.csetl.org/curriculum_units.htm.*

2. Lisa J. Boerum, "Laws of Science," 1999, a Standards-Based Curriculum and Assessment Prototype available from the Center for the Study of Expertise in Teaching and Learning (CSETL) Web site, *www.csetl.org/curriculum_units.htm.*

3. Elizabeth Bedell, "A Quiet Garden," 2000, a Standards-Based Curriculum and Assessment Prototype available from the Center for the Study of Expertise in Teaching and Learning (CSETL) Web site, *www.csetl.org/curriculum_units.htm.*